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SOME OBSERVATIONS ON THE LIFE-HISTORY OF

SCLEROSTOMUM TETRACANTHUM DIESING,

AND ON SCLEROSTOMIASIS IN EQUINE ANIMALS; IN CONNECTION WITH A SO-CALLED OUTBREAK OF "SURRA" AT SHILLONG.

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BY

Surgeon G. M. J. GILES, M.B., F.R.C.S.,
Medical Officer, Lawrence Military Asylum, Sanawar.

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G M Giles

Some observations on the life-history of ***Sclerostomum tetracanthum*** Diesing, and on Sclerostomiasis in equine animals; in connection with a so-called outbreak of "Surra" at Shillong.

BY

SURGEON G. M. J. GILES, M.B., F.R.C.S.,
MEDICAL OFFICER, LAWRENCE MILITARY ASYLUM, SANAWAR.

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FOR some eighteen months past there has been present, among equine animals at Shillong, an epizootic, which has resulted in the loss of a large number of valuable animals.

Though by no means confined to them, this outbreak was especially severe among the transport mules attached to the regiment stationed there; and I understand that, from first to last, between sixty and seventy of these have either died or had to be destroyed.

When first the mortality became serious, a veterinary surgeon was sent to investigate the nature of the outbreak, and his diagnosis was, that the disease was "Surra." His recommendations consisted in the removal of the lines to a new site, and in various sanitary improvements, the adoption of which have undoubtedly gone far to diminish the severity of this epizootic. The disease cannot, however, be said to have been stamped out, as cases have continued to occur ever since; and it is these later cases that have come under my own observation, some six having been examined during the period of about five months that have elapsed since my attention was first directed to the matter. These latter cases, I am told, are in every way identical with those that appeared before them, and it is on this account that I have spoken of the cases as "Surra." As to what sort of cases are called by this name elsewhere I am unable to say, and whether the cases I am about to describe should be properly called "Surra" at all must remain entirely a matter of opinion. All that can be said is that the cases I have seen formed part of a continuous epizootic the earlier cases of which were diagnosed as "Surra" by competent veterinary authority, and that there can be no practical doubt that the earlier and later cases were of the same character. It is likely enough that a good many, quite distinct, communicable diseases may be included under this term, and, from the analogy of what we find in human medicine, it may be expected that nothing but confusion can arise should any one attempt to pin down a loose vernacular term such as "Surra" to some one definite pathological condition. The cases

I have personally examined were undoubtedly instances of helminthiasis, and, whatever may be called "Surra" elsewhere, that these animals died from the action of nematode parasites, and from no other cause, is a matter which admits of not the slightest doubt; and it is equally certain, whatever may be the correct vernacular name of the disease, that such cases are a source of very heavy mortality in Assam; and I have collected some information tending to show that the same is the case in Burma.

As will be seen in the sequel, the disease is one which can hardly spread to any great extent in a dry climate; but, as it is by no means unknown in Europe, a tropical temperature is by no means essential. Most of the animals I have examined were perfect museums of parasites; but, of the various species found, only two[1] can be considered as effective in producing the mortality, and these are two strongyloid mematodes, closely allied to each other and to the well known *Dochmius duodenalis* found in the human subject, which latter parasite has of late been causing a terrible mortality among human beings in Assam, and the life-history of which it has lately been my special business to investigate. These two parasites are *Sclerostomum tetracanthum* Diesing and *S. equinum* (Rudolphi), and, though the latter not unfrequently determines the sudden death of animals, it is more especially the former which is the efficient agent in the present epizootic, and it is its life-history only that it is proposed to discuss in the present paper. In it I have preferred to adhere to the generic name *Sclerostomum*, as the worm agrees in all its characters with the definition of the genus, and I can see no advantage in forcing it into the already unwieldy genus *Strongylus.*

The first case that was brought to my notice was that of an officer's charger, which was sent to me by Dr. Hall as a case of "Surra," and, knowing the interest I take in epidemic disease, he believed would interest me. I was at once struck with the extraordinary resemblance which the case presented to one of anchylostomiasis in the human subject. There was the same weakness and wasting, and the same characteristic deadly pallor of the mucous membranes; indeed, the similarity was so striking that I at once proceeded to examine the dung microscopically: nor was my astonishment diminished when I found that it contained countless numbers of ova, absolutely identical in general appearance with those of *Dochmius duodenalis.* A reference to the micrometer, indeed, showed them to be considerably larger than the ova of the latter; but, in all other points, the resemblance is so close that it would be quite impossible to distinguish them by any other test than measurement. Shortly after, the animal's recovery being obviously hopeless, its destruction was decided upon by a board of survey, and I obtained the opportunity I had been hoping for of seeing the actual parasites which produced the eggs, and of whose exact nature I could only give a guess, as none of them could ever be found in the animal's dejecta. As a matter of convenience, the animal was destroyed, and the examination made, at the mule lines, as I could then have the assistance of the transport conductor, and of the salutri, who were necessarily more accustomed than I to dissecting such huge subjects. While walking to the spot with Mr. J. Brown, the transport conductor, I explained to him what I expected to find, and to my surprise he replied, "I know you will find exactly what you expect then, Sir, for I have found worms of the sort you mention, sometimes absolutely in buckets-full, in all the cases we have lost here, and we have had some 60 either died or destroyed; but I was only laughed at when I said I thought they were the cause of death:" and he added that it was in the stomach and large intestine that they would be found. On opening the animal's cœcum a most extraordinary sight presented itself. There was absolutely no exaggeration in the conductor's statement, for so enormous were the numbers of worms that the whole of the intestinal contents seemed nothing else than a writhing mass; and I believe that, could they have all been collected and cleaned, they would have more than filled an ordinary stable bucket. It will be best, however, to give a full account of this case, as it is typical of all the rest, and so will save the necessity of entering much into detail in the others. The animal had been ailing for some three months, the principal symptom being wasting. It was said to have had "fever" on several occasions, but the temperature had not been taken by the thermometer. It fed greedily as a rule; but the appetite was capricious, and occasionally it would be off its feed for days. The most prominent symptoms at the time it came under my observation have already been described: for the rest, its organs seemed healthy, the sounds of the lungs and heart presenting nothing peculiar. I examined the blood on three several occasions, and could find no trace of the so-called "Surra" parasites (*Trichomonas Evansi*) in the blood, though this does not imply their necessary absence throughout the case, as their presence is acknowledged to be intermittent. On opening the abdomen, the peritoneal cavity was first carefully examined, and found to be healthy, with the exception that three specimens of *Filaria papillosa* Rudolphi were discovered; but there was not the faintest sign of irritation about the situations where they were found. The cœcum was then opened, and the upper half of the large intestine were found to contain immense numbers of worms. Putting aside *Oxyuris curvula* Rudolphi, of which a few were present, they might be divided into two categories, although a close search would always show large numbers of intermediate size. The first or larger sort[1] were about three-fourths of an inch long, greyish red in colour, or with a distinct black streak throughout their length, owing to their being gorged with blood. The largest specimens (female) have a mucronate tail, while the males, which scarce exceed half an inch in length, have a large copulatory bursa. These larger specimens, of both sexes, were almost all adherent to the mucous membrane in exactly the same way as *Dochmius duodenalis* is found in the human duodenum, and so firm is the grip with which they attach themselves, that it was often not altogether easy to detach them without damaging them, and the mucous surface would be pulled out into a conical projection by the effort. The large amount of blood which they habitually abstract was shown by the frequency with which long tails of clotted blood would be found hanging from the anus of the worms, and by the numerous streaks of blood to be seen amongst the intestinal contents. Although very numerous, for many thousands must actually have been present, the number of these larger specimens was quite insignificant in comparison with that of the smaller specimens forming the second category. These latter, however, proved to be all sexually mature, and large numbers (at least a quarter of the whole number) were found actually *in copula.* The main difference was that they were rarely, if ever, found adherent to the mucous membrane, and that it was quite exceptional to find any evidence of their containing blood. Apparently the smaller ones do not indulge in the habit of blood-sucking, at any rate as regularly as the larger kind. These smaller worms were present in such enormous numbers that the term "buckets-full" is no exaggeration to apply to the quantity : it would be impossible to make an even approximate calculation of the actual numbers; but the figure could certainly not run to less than six digits. Alike large and small specimens were confined to that portion of the large intestines in which the contents are semifluid, and still undergoing digestion. In the lower parts of the bowel, their numbers steadily diminished, and in the rectum, where the dung was quite formed, not a single specimen could be found. On closer examination these parasites proved to be *Sclerostomum tetracanthum* Diesing.

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[1] I have since found that, under the name of *S. equinum*, I included two closely allied species, *S. equinum*, and another, which appears to be new to science, and which I describe in a note, following the present paper, under the name of *S. robustum*, sp. n. Hence three species were concerned in the mortality.

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[1] Afterwards identified as a distinct species *S. robustum* sp. n.

The whole of the mucous mm brane was closely spotted with the marks of recent and old bites inflicted by the parasites, from 10—20 being counted on an average square inch. In addition to these lesions, the bowel, when held up to the light, was seen to be studded with opaque spots about the size of a lentil; and, on feeling these spots between the finger and thumb, a distinct sensation, as of an imbedded small shot, could be made out. Dissection of these spots under the simple microscope revealed the fact that each contained, coiled up within it, an encysted worm, the largest of which were about the size of the smallest of those found free in the intestines, and a closer examination brought to light a number of small undercut ulcers, from which encysted worms had evidently but recently escaped.

The small intestine was free from parasites ; but the stomach contained immense numbers of the smaller parasites, and was dotted with cysts in exactly the same way as the cœcum. The mucous membrane presented appearances closely resembling those found in human anchylostomiasis, only in an exaggerated manner. There were the same irregular, petechial markings, and the same leathery appearance along the greater curvature, the same dull, slaty blue tint from chronic inflammation. All the other organs were healthy, except the liver, which was dotted throughout its substance with small whitish tubercles. These are probably cestode tubercles ; but I have not as yet had sufficient leisure to decide the point with certainty.

Now, in this case, there is absolutely nothing to account for the horse's condition except the presence of the parasites, and, when their immense numbers, and the serious nature of the lesions they cause are considered, it is difficult to understand how any one can consider the cause inadequate to the effect, especially when it is remembered how much more serious in degree the injuries produced are than those effected by *Dochmius* in the human subject, about the fatality of which few now entertain a doubt. There seems, however, a sort of hostility to recognising the pathological importance of entozoa, alike among the medical and veterinary professions, and most of us can remember the difficulty with which the perfectly obvious connection between anchylostomiasis and the pernicious anæmia which it causes gained general acceptance.

In the case of the particular parasite which we are now discussing, its fatal importance seems to have been generally overlooked in India ; but in Europe its adequacy to cause widely-spread mischief has been clearly recognised, at any rate by such as are best fitted to judge of such a matter. Speaking of *Sclerostomum tetracanthum*, Cobbold says: "Second only in clinical importance" (to *S. equinum*) "is the little four-spined strongyle (*S. tetracanthus*). The sexes, often seen united, are nearly of equal size, the largest females reaching nearly three-fourths of an inch. They infest the cœcum and colon, and have been found in all varieties of the horse, ass, and mule. The worm occurs in immense numbers, and is a true bloodsucker. Its presence occasions severe colic and other violent symptoms, often proving fatal to the bearer. As already announced in connection with my account of the tape-worms of the horse, this little worm may produce a virulent epidemic (epizooty). In the sexually immature state the worm occupies the walls of the large intestine, where it gives rise to congestion, echymosis, inflammation, and the formation of pus deposits. The species is readily recognised by its bright red colour, by the four conical spines surrounding the mouth, by the two neck bristles, and by the long three-lobed hood of the male, the posterior, three-cleft ray having a rudimentary or fourth branch attached to its outer edge. In some specimens sent to me by Mr. Whitway. I found this supplementary process fully twice as long as Schneider has represented it * * * * * * *. As regards the course of development of this worm we have yet much to learn. Although the worm is a frequent cause of epizooty in this country, it appears to be but little known on the Continent * * * * * As already remarked, the evidence of the frequency and destructiveness of this little worm in England is overwhelming."

The facts recorded in this extract comprise, practically, all that is said about the development of the parasites; and it is the gap left between the deposition of the ova in the dung of the one host, and the entry of the young parasites into another that I have been able to fill up, and which forms the essential part of the present paper.

To return, however, to the clinical aspect of the disease. The second case was that of a transport mule, which was in a dying state at the time of the destruction of the horse. The animal was too weak to stand and lay helpless on its side, but was perfectly conscious and fed quite greedily when grass was given it by hand. The breathing was deep and laboured, but the breath sounds were normal (apnœa of bloodlessness). The mucous membranes were absolutely bloodless, but there was but little subcutaneous œdema; and there was no true paralysis, but only extreme weakness. Bed sores were commencing to form over the haunch bones; the temperature was 97·8° (sub-normal). No worms could be found in the dung, but it contained countless ova. The blood was twice examined, and no trichomonads could be found on either occasion.

The animal was practically at the point of death when shot, and, *post mortem*, the changes found were practically identical with those found in the first case, only in a more advanced condition; and just as the latter exhibited appearances corresponding to those found in moderately advanced anchylostomiasis, this case showed those corresponding to the last stages of that disease. That no œdema of the extremities was present is probably due to the fact that the mule had been several days lying constantly on its side, but dropsies of the internal organs were present in a marked degree, the lungs being œdematous, and the pericardium and peritoneum full of fluid. The animal harboured, moreover, an even greater variety of parasites than the first case. None were found in the stomach, but this organ presented all the characteristic appearances of the first case; so that it is certain that they had been present there during a previous stage of the case, a fact which makes it probable that the worms, after escaping from encystment in that organ, soon pass along the intestine to the large bowel. In addition to *S. tetracanthum*, which was present in enormous numbers, 53 being counted in a single ounce of the fluid contents of the cœcum, two good-sized worm aneurisms, containing immature *S. equinum*, were found on the larger branches of the mesenteric arteries, and a few mature specimens of the same worm were found free in the intestine; but I doubt if these had much to do with the fatal issue of the case. Besides these, whole handfuls of a small amphistome fluke (*Gastrodiscus Sonsinonis*, Cobbold) were found in the cœcum and colon, in which situation also a few specimens of a pentastome, near *P. tænioides*, were discovered; while the stomach contained a large number of bots, and the small intestine, several *Ascaris megalocephala* Cloquet.

In all, seven *post-mortem* examinations have been made, and in every one there could not be the least doubt that the cause of illness was mainly the presence of *Sclerostomum tetracanthum*, though, no doubt, its ravages were assisted by other parasites, and especially by *S. equinum*. In addition to the parasites already enumerated, the last case examined harboured, in the stomach, large numbers of *Spiroptera microstoma* Rudolphi; but a separate account of the other cases would only involve useless repetition, and take up needless space. Before quitting the clinical side of the subject I may remark that, from what I have seen, I am inclined to think that the colicky pains described in Cobbold as symptomatic of the presence of *S. tetracanthum* did not form by any means a pro minent symptom of the cases I have witnessed. In these, recurring feverish attacks, followed by profound anæmia, wasting and exhaustion, with, at the end, dropsical symptoms, formed the most prominent features of the clinical picture. I am inclined to think that, when colic occurs, it is due to the associated presence of *S. equinum*. It must be remembered that Cobbold's information on this point is second-hand. The pressure, however, of my legitimate work prevented my being able to bestow much time to the observation of still living animals, and also prevented my ascertaining, as I had intended to do, in how large a proportion of apparently healthy animals fewer or more of the parasites might be harboured. I have no doubt that a very large number of not only apparently, but of really, healthy animals do harbour a certain number of the worms; for, unlike *S. equinum*, where a very few may indirectly cause sudden death, the severity of a case must be directly proportional to the number present, and, up to a certain limit of number, it is probable that no symptoms would result from their presence.

Such, then, being the circumstances under which these parasites were met with, I will now proceed to describe their free, or Rhabditis stage, as far as I have been able to observe it. The term Rhabditis stage is used because it has come into general use to denote the intermediate free stage of certain alternately parasitic nematodes. As a matter of fact, in this particular instance, the term is rather a misnomer, as the free *S. tetracanthum* I am about to describe, correspond much better to Rudolphi's genus Liorhynchus than to Dujardin's Rhabditis.

When my first equine patient was brought to me, but before its destruction enabled me to identify the parasite, I started cultivations of the ova contained in the dung, working on the same lines as those which experimentation with *Dochmius* ova indicated as most likely to succeed. Several cultivations accordingly were started with the diluted dung spread over sand; others with the dung simply placed in a covered crystalising glass; and others with the dung spread over patches of garden soil enclosed within four planks. In all of these experiments the ova hatched out on the third day after deposition, the mean temperature of the air being a little below 70°F., and development proceeded to a certain extent in all; but in no instance did it proceed to the adult Rhabditis stage. Some condition, necessary to the welfare of the embryos, was clearly wanting, and, for some time, I despaired of getting any further success. About nine days after the start, a chance seed spouted up within the cultivation in the open, and, on the young leaves, was found a Rhabditis much further developed than any that had been hitherto obtained, a fact which seemed to show that plants formed, as it were, the intermediate host of the parasite. About the same time I made the disagreeable discovery that one of my own horses was affected with the disease. For some time, in spite of liberal feed, he had been getting out of condition, and at last he became obviously ill and unfit for work, and an examination of his dung showed that he, too, harboured large numbers of the same parasite as that which had brought about the destruction of the officer's charger first seen. Now the stable sweepings were thrown on to a heap near the stable which the conservancy carts persistently avoided clearing away; and, as it was placed on a sloping piece of ground, the drainage from the heap ran down on to the grass below; so, following out the hint given by the stray seedling, I examined first the dung heap, and then the herbage near it. The dung heap, like my cultivations, swarmed with immature Rhabdites, and plenty of such were found also on the grass; but here, in addition, completely mature specimens of both sexes, and less mature ones of all grades were found; so that the whole question of the life-history of the parasite was solved, it being evident that, while earlier phases of development of the free stage take place in horse-dung, the Rhabdites can only attain maturity by crawling out of their original home on to grass or other forage plants. No one special species or class of plants appeared to be particularly affected by them, and they were found indifferently on grass, and upon leguminous, and other dicotyledinous weeds, that flourished near the heap, the greatest numbers being naturally found close to it, though a few could be discovered, as much as 15 feet from the centre of infection.

Thus, wherever dung is dropped by an infected animal, an area of herbage, varying in extent with the slope of the ground and the amount of rainfall, will become so infested with rhabditic sclerostomes in various stages that the infection of any equine animal feeding on the grass is perfectly inevitable, and as the Rhabdites appear to be capable of continuous reproduction and multiplication, there is obviously, in damp climates, no possible limit to the period during which any given area may remain in a dangerously infective condition; for, as far as I can make out, all the conditions for repeated generations are found on forage plants, once the embryos hatched out from the parasitic eggs have escaped from the dung of their birthplace.

Having thus traced out briefly the various steps in the investigation, I will now enter upon the description of the free, or Rhabdites, stage of this very destructive little nematode.

The number of eggs produced by the entozoic worms is enormous, and, coupled with the immense numbers of worms often present, renders the diagnosis of the disease by microscopical examination of the dung so easy a matter that an inspection of even the most cursory character usually suffices. The ova when deposited measure $\frac{1}{231}''$—$\frac{1}{250}''$ (about 0·11 mm.) long by $\frac{1}{480}''$ — $\frac{1}{500}''$ (about 0·05 mm.) wide, being thus rather narrower in proportion to their length than those of *Dochmius duodenalis*, to which, as already remarked, they present a strong resemblance in all other points. They present too, in perhaps an even more marked degree, the flattening of their longer sides, and exhibit a more or less segmented yelk, surmounted by a perfectly clear space, which is wider at the poles than elsewhere, the shell being as perfectly clear and transparent as the zone of fluid within it, and exhibiting microscopically a marked double contour. In freshly deposited dung, the ova will usually be found to be 4—12 segmented, but even earlier stages, and others in which the first indications of the outline of the embryo can already be made out may occasionally be found; but under no circumstances do they ever hatch out within the intestine. Doubtless, as Leichtenstern has experimentally demonstrated in the case of *Dochmius* ova, the cause of the ova not hatching out while still within the intestine is, that the presence of a free supply of oxygen is essential to the process, and the supply of this gas within the intestine is very limited. As might be expected from the general fragility of the envelope of the ova, they hatch out very shortly after deposition.

Experiments were made with cultivations of diluted dung spread over moist sand, with the slightly moistened dung set aside in a covered glass, with the dung suspended in water, and also with dung spread over a patch of garden soil enclosed within four planks. As far as concerns the hatching out of the eggs, it seems of little moment which plan be followed, though the experiments gave some reason for thinking that the more abundant the supply of moisture, the more rapid was the process, the eggs suspended in water hatching out, on the whole, more rapidly than those which were kept simply moistened; but, though the earlier stages of growth proceeded in water at perhaps an accelerated rate, they soon came to a standstill, and it soon became evident that water could not be considered a natural habitat for the Rhabdites. These points are illustrated by the following experiment:—

April 26.—Some dung from an affected animal, containing immense numbers of ova, diluted with water, and spread over a surface of clear sand in a crystallising glass.

April 27.—Ova further advanced in segmentation, but as yet no embryos. A portion of the surface of the cultivation set aside in a shallow tray of water.

April 28.—In the original cultivation there is but little change to be made out: on the other hand, in the material set aside in the tray of water, a few embryos have already hatched out, and most of the ova contain lively embryos.

April 29.—Ova in original cultivation hatching out. There are now large numbers of embryos in the tray of water, some of which have grown considerably, and are sufficiently advanced to admit of the genital area being made out.

April 30.—The embryos in the original cultivation are now about as advanced as those observed yesterday in the tray of water, in which latter, however, no further advance has taken place.

May 3rd.—No change has taken place in either the sand cultivation or in the tray of water.

From this date no further development of the embryos took place, and, though many survived for a considerable time, their numbers steadily diminished, until, by the end of the month, no trace of nematode life could be discovered in even the original cultivation, all those that had been kept in water having died out within ten days of the commencement of the experiment.

In an experiment conducted with horse-dung simply damped, the development was even slower, ova still living, but unhatched, being observable as late as the eleventh day; while the ultimate fate of those that hatched out was the same as that attending the inhabitants of the first cultivation.

The experiment conducted in the open air, the dung being simply spread over an enclosed patch of garden soil, succeeded somewhat better, the embryos growing considerably, and their generative organs developing to such an extent as to occupy an even larger share of the body cavity than the intestinal canal. They, however, never reached the stage of sexual differentiation, and it was evident that some essential condition was wanting to enable them to complete their development. A hint as to the nature of this desideratum was, as I have said, first afforded by my finding, on the cotyledonary leaves of some chance seedlings that had sprung up within the little enclosure a Rhabditis which, though not yet mature, was further advanced than any I had yet seen.

It was about this time that I found that my own pony was affected. He had been getting out of condition for some time, and one day the syce reported that he had refused his food. On more closely examining the animal I found that he presented, in a less marked degree, the same symptoms as the horse I had already examined, and microscopical examination of the dung confirmed the diagnosis. I also found that near the stable a considerable dung heap existed, and I soon found that there was no need for any further artificial cultivations, as a very large one, under perfectly natural conditions, was now at my command.

In the actual dung heap I could find no specimens further advanced than those I had already reared ; but, on examining the rank vegetation on and about it, I found abundant representatives of all stages up to maturity.

When first hatched out, the embryos are extremely transparent, and the details of their structure can only with difficulty be made out, the pharyngeal bulb being the only structure whose outline is at all distinct. They are provided with a long lash-like tail, quite half as long as the body proper, the lash tapering to such extreme tenuity that the highest powers are necessary to the resolution of its entire length, the body itself tapering off so gradually into the lash that it is hard to define their proportional length. Exclusive of this lash, they measure about $\frac{1}{80}''$ (0·34 mm.) in length by rather less than $\frac{1}{1000}''$ (0·025 mm.) in diameter. Although I have frequently examined embryos just escaped from the egg, I could never make out any pulsatile action of the pharyngeal bulb, such as is seen in all the embryos of *Dochmius duodenalis*, but only irregular slow contractions of the pharynx. They grow with great rapidity, so that in a few hours they have attained a length of $\frac{1}{50}''$ (0·5 mm.), and have increased considerably in thickness. By this time the outlines of the internal organs have become distinct, the intestine being marked out as a distinct granular mass, between the lining cells of which the lumen of the tube pursues the serpentine course characteristic of young nematodes. A relatively large share of the body length is taken up by the pharynx and its bulb, a third of the body proper being so occupied, the pharynx being exceptionally wide and strong, and rather widening out at its aboral end than forming a distinct bulb. The portion of the body length occupied by the intestine proper is relatively short, only exceeding that of the pharyngeal portion by about $\frac{1}{800}''$ (0·034 mm.), the anus being placed rather far forward, so that the intestine does not extend into the long tapering tail. They change skin frequently, and any specimen containing many of them will be sure to exhibt a considerable number engaged in the process of getting rid of their old integuments, the long empty chitinous tube, still attached, giving rise to all sorts of queer appearances.

The development of the generative organs and of the lemniscus is exactly similar to that of *Dochmius duodenalis*; so that to enter into the details of the process would necessarily be merely a repetition of the description of the development of the Rhabditis of that parasite given in my recent "Report on the diseases known in Assam as Kala azar, and Beri beri;" and I will therefore proceed at once to the description of the mature Rhabditis, which presents such considerable differences from *Dochmius* that there would be no difficulty whatever in distinguishing the two species, even were they to be mixed together in a single tray. As far as I could make out, the emigration from their original home in horse-dung, on to plants generally takes place just before the distinction between the sexes first appears, that is to say, at a stage when the generative gland has already attained considerable dimensions, but at which the future sex cannot yet be determined.

The most distinguishing character of the Rhabdites, after their migration from the dung in which they were born on to forage plants, is the possession of a peculiar mouth armature, specially suited to subserve their needs in this new situation. This consists of a sharp, protrusible, chitinous style, which appears to be hollow, and to consist essentially of a prolongation of the pharynx. With this structure they are doubtless able to pierce the delicate cuticle of the plants that harbour them, and so to extract the nutritious juices contained in the cells beneath. The pharyngeal bulb, at no stage very distinct, is reduced to a mere widening and thickening of the posterior third of the pharynx, and shows no sign of the peculiar armature seen in the Rhabditis of the closely-allied *Dochmius duodenalis.* This thickened posterior portion communicates with the mouth by means of a very delicate wavy tube, the musculature of which is comparatively weak. Its hinder end is encircled by the great central nerve ganglion, from which proceed forwards a number of fibres, beaded with smaller ganglion cells; the whole structure of the nervous system differing, in fact, in no way from the arrangements found in closely allied species, and therefore scarcely meriting any special notice.

The mature male *Rhabditis* attains or even exceeds $\frac{1}{16}''$ (1·7 mm.) in length, of which $\frac{2}{9}$ths is occupied by the pharyngeal portion of the digestive tube, the remainder being occupied by the intestine, testes and lemniscus. The anterior extremity of the body is much attenuated, while the caudal is so abruptly conical as to be almost truncate, all trace of the long lash-like tail of the earlier embryos having disappeared. The copulatory spiculæ and the common opening of the spermatic ducts and intestine are placed very close to the end of the body. There is no copulatory bursa or expanded membrane of any kind; but, in place of this, the worm is provided with a powerful clasping apparatus, consisting of four recurved hooks placed along the sides of the aboral extremity of the body. The hindmost pair of these is much the largest, measuring about $\frac{1}{800}''$ (0·034 mm.) long, and being placed just in front of the copulatory spicules and about $\frac{1}{250}''$ (0·1 mm.) from the caudal extremity. The other three pairs are subequal, and only about half the length of the hindmost; the second being placed only about $\frac{1}{800}''$ (0·034 mm.) in front, while the other two pairs are placed fully $\frac{1}{400}''$ (0·068 mm.) apart.

The fully grown females measure from $\frac{1}{12}$—$\frac{1}{10}''$ (2—2·25 mm.) in length, and closely resemble the males in all points, except in their greater size and in the absence of the clasping hooks. They are about $\frac{1}{200}''$ (0·136mm.) thick at their greatest diameter, *viz.*, opposite the generative opening, which is placed rather nearer the caudal than the oral extremity of the body.

That they are truly only the free stage the parasitic *Sclerostomum tetracanthum* is shown, not only by their having been traced in all stages from undoubted eggs of that parasite, but also by the absolute identity in appearance and size of the ova of both stages. The eggs, however, of the free stage are, at the time of deposition, always in a much more advanced condition than those of the parasitic stage, nearly always containing a lively embryo, so that ova exactly similar to those met with in horse-dung can only be found within the maternal oviducts of the Rhabdites. They give birth to a considerable number of ova, but do not approach the parasitic stage in prolificness. In no case did I observe any of the ova to hatch out within the body of the female, and her progeny resemble in all points the embryos hatched out from the eggs of the parasitic stage of the worm.

In this description I have, as far as possible, avoided, going into too minute details, as to do so not only should I have to repeat much of what I have recently written on the subject of *Dochmius duodenalis*, but, after all, beyond a few measurements, no descriptions of organisms such as these can equal fairly executed plates, and several drawings of various stages of the free stage will be found appended to this paper, which, being made with the camera lucida, can be vouched for, at least as to accuracy of outline.

Considering that ordinary grasses and other forage plants form the habitat of the *Rhabdites*, the method by which they gain access to the intestinal canal of herbiverous animals is perfectly obvious, as the worms cannot fail to be swallowed along with the infested plants. Once the embryos have so invaded a suitable host their remaining life-history is already fairly well known, and is described in some detail in Cobbold's "Parasites," page 374, *et seq.*[1] As therein described, there can be no doubt that the worms, as the first act of their parasitic life, bore into, and encyst themselves in, the intestinal submucosa, and there acquire the peculiar four-spined mouth armature, and undergo the initial stages leading up to sexual maturity.

Cobbold (1879) states, on the authority of Leuckart, that these cysts are limited to the cœcum and colon, a mistake natural enough, as the latter authority had had only a single opportunity of examining a case; but, as a matter of fact, they may also be frequently found encysted in enormous numbers in the walls of the stomach, and, even when not found there at the time of one's examination, plain traces of their previous presence may be met with in nearly every case in which they are at all abundant in the lower bowel. These lesions consist in cicatricial changes marking the site of the deserted cysts, and vary in character according to the length of time that has elapsed since they were occupied. Immediately after the worms have escaped, the cysts will be found to be filled with fresh blood clot, and subsequently, as the clot decolourises and shrinks, they become little nodules of caseous-looking matter, surrounded by a zone of infiltrated tissue. Finally the contained mass becomes very small, and may calcify, but the infiltrated zone remains for a long time as a thickened nodule, of almost cartilaginous consistency, feeling much like an inbedded small shot. Where, as is often the case, the scars of the deserted cysts are packed closely together, a mammillated appearance results, together with a general thickening of the walls of the organ, which is extremely characteristic, and, once seen associated with recently escaped worms, is easily recognised as a sequel to their residence, even when no worms, either free or encysted, are to be found in the organ at the time of examination.

Sections of the affected organ showed that the functional efficiency of the often large areas of its surface affected must be almost abolished; for a large portion of each section was seen to be occupied by cicatricial tissue, often placed so superficially as to entirely block up the openings of the peptic glands. When first I met with these gastric worms, the wide difference of their habitat from those first met with in the lower bowel made me suspect that I might have to do with a distinct species; but a subsequent close comparison of specimens from each situation convinced me of their specific identity, and, though it is extremely rare to find any of them in the small intestine, I have since met with a few specimens apparently on their way from stomach to colon, and also a few stray, scattered worms encysted in the submucosa of this portion of the bowel. While, however, this latter occurrence serves as a connecting link between the two commoner situations, it is so exceptional that it must be considered abnormal.

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[1] *Vide* also "Description of *Strongylus Arnfield*" (Cobb.) with observations on *Strongylus tetracanthus* by T. Spencer Cobbold in Trans Lin. Soc. 1886, pp. 284—93. On page 291 will be found a good account of the bibliography of the species.

Although the submucosa of the stomach, and occasionally of the small intestine, serve as localities for the encystment of the young parasites, the conditions met with within the lumina of these viscera do not appear to be suitable to their prolonged residence when they have escaped from their cysts. None of the worms found free within the stomach had attained their full growth, and as, to all appearance, they do not take up the habit of blood-sucking until quite fully grown, no worms will be found adherent to the wall of the stomach, even in a body opened immediately after death.

In the great intestine too, besidesf ully grown worms gorged with blood, and still adhering to the mucous membrane, much greater numbers of smaller ones will be found free in the bowel, whose intestines show no evidence of blood-sucking propensities. These smaller worms seem to subsist on the nutritive fluids with which they are surrounded, and are never, so far as I have seen, to be found adherent to the mucous membrane.

Though not fully grown, these small worms are sexually mature, and may so often be found in copula that it is rather the rule to find them so than otherwise, and the adhesion between the couples is so firm that hardly a doubt can be entertained that their union is assisted by some viscid secretion. Indeed the fact that it persists long after the death of the worm, when all muscular contraction must have ceased, almost proves this to be the case. All worms met with, free in the intestine, whether full-grown or otherwise, are sexually mature, though it is possible that they may not begin to lay their eggs until, with complete growth, the power of gaining a more abundant supply of nourishment is acquired.

It is while encysted that the changes that lead up from the already described Rhabditis progeny to sexual maturity take place, and hence the statement in Cobbold's "Parasites" (*fide* Leuckart) that "The development of the sexual apparatus had not yet commenced is a mistake, arising probably from the limited material for observation at his command. So far from this being the case, it is rare to find an encysted worm in which the sex cannot already be made out, provided attention be paid to the position of the rudiment of the generative gland ; and all stages, from indeterminate Rhabdites still provided with the hollow styloid mouth armature, to sexually mature parasites, just ready to escape with a nearly complete dental apparatus are to be found. The specimen figured for example, though far from sexually mature, is quite clearly a female, the generative aperture being already clearly discernible about the middle of the body, though the generative gland itself, as far as its histiological elements are concerned, might be either testis or ovarium. In spite of this, taken as a whole, the sex of the animal might be diagnosed from an examination of the gland alone, for the most advanced cells are placed in the middle of the organ and not at the aboral extremity, as would be the case in a male histologically indeterminate gland.

While encysted, the little worm undergoes several changes of skin, and, by the time it is ready to escape, is fully equipped with the peculiar mouth armature of the adult. The buccal cup first appears as a quite unarmed cavity. Next, the circlet of minute denticles, that comes behind the circlet of fimbriæ in the adult, is developed. The four labial spines next appear, but are rather papillæ than spines at this stage ; and, finally, the circlet of fimbriæ and the ring of plates round the pharyngeal opening, made their appearance. Probably more than one ecdysis is undergone by the worms after escaping from encystment, for specimens undergoing the process are not hard to find, though I was unable to satisfy myself of the occurrence of the so-called cocoons described by Cobbold.

Appearances that might be interpreted somewhat in this fashion I have indeed met with; but they appeared to me to be better explicable as accidental accumulations of fæcal matter round a worm undergoing ecdysis. Nematodes undergoing this process are always in a very sluggish state, and so would more readily serve as the nuclei of such concretions than the actively moving creatures they are when not so engaged ; but I must repeat that I look upon the occurrence as purely accidental, as worms changing their skins were far more commonly to be found without any such encumbrance than with it.

Thus it will be seen that, during the life-history of this worm, it inflicts two serious lesions on the intestine. First, it bores its way into, and encysts itself within the substance of the mucous membrane, setting up changes which result in the certain impairment, and often entire loss, of functional activity in the little patch of digestive mucous membrane affected ; and secondly, it, with the powerful teeth of the fully grown worm, gnaws into the mucous membrane and continuously sucks its victim's blood, and, as the period of sexual vigour during which the worm exhibits this blood-sucking propensity is probably a tolerably long one, this second class of lesion is one which must be again and again inflicted by the same worm.

In the face of these facts it appears difficult to understand how any one can doubt the ability of this parasite to bring about a fatal result.

No one now doubts the ravages wrought in the human subject by *Dochmius duodenalis*, and yet the equine parasite is absolutely much larger, and, even relatively to its larger host, at least as large as the human scourge; added to which, it is generally present in numbers which put the worst cases of anchylostomiasis into the shade.

Cobbold, indeed, recognises that it has caused "virulent epizootics" in England; but, in spite of his teachings, the pathological importance of the worm appears to be but little recognised, at any rate in India.

Shortly after I had made out that the so-called "Surra" among the transport animals at Shillong was really sclerostomiasis, I wrote a short letter to the "*Pioneer*" with the view of ascertaining whether or not similar cases had been met with elsewhere.

My object was to collect information through ordinary correspondence, and nothing was further from my intention than to enter into a public controversy, at any rate in the columns of an ordinary newspaper, which, though well suited for a notice of enquiry on any subject, is recognised as hardly a suitable medium for a discussion of so essentially technical a character. In place, however, of sending me the results of his experience in letter form, Mr. Steel, the well known and learned head of the Veterinary College at Poona, replied in the columns of the "*Pioneer*" in a way that showed he entirely misunderstood me, for he was clearly under the idea that I had propounded the thesis that all "Surra" was sclerostomiasis, whereas all I had asserted was that certain cases which had fallen under my own observation, and were shown me as instances of that disease were of that nature, and had asked for information as to the prevalence of the parasites elsewhere.

I have no desire to re-open a controversy based entirely on a misconception of my views, nor should I allude to the incident here were it not that Mr. Steel's letter may, I presume, be taken to fairly represent current veterinary opinion on the subject, and he definitely commits himself to the assertion that the strongyles in question are "inadequate to explain the phenomena of Surra."

Now, as I gather from Veterinary Surgeon R. W. Burke's excellent little work on "The tropical diseases of the Horse," the characteristic phenomenon of "Surra" is an inexplicable pernicious anæmia; in fact, his chapter on the subject is headed "Surra, or pernicious Anæmia," and the adequacy of these strongyles to bring about a pernicious anæmia is a matter on which incredulity is difficult to understand.

It may be, however, that Mr. Steel's meaning is that the existence of the strongyles will not explain the presence in a large proportion of cases of the so-called "Surra parasites" (*Trichomonas Evansi*), and of course there can be no possible connection between the two organisms; but, until these monads have been cultivated apart from their host, and a pernicious anæmia produced in a healthy animal by infection with a pure cultivation, the connection between monad and disease must remain a mere matter of opinion.

As is well known, these monads are congeneric, and more than probably conspecific with certain morphologically identical organisms found hy Crookshank and others in the blood of healthy rats, and if they be really so harmful to horses, the immunity of the rats is very hard to explain. So that whatever proportion of the group of cases popularly called "Surra" may be attributable to sclerostomiasis (and it is very probable that several distinct causes of pernicious anæmia may contribute to the total), I should personally prefer to look upon the coincidence of the presence of monads in the blood as accidental, until a rigid demonstration of a causal connection be forthcoming. The most that can be said of the researches of Evans, Steel, and others on this point is that they are suggestive of the possibility of a causal connection between the monads and the particular set of cases under their observation.

This applies especially to their inoculation experiments, which, being conducted with blood, might bring about deaths by some form of septicæmia; and, putting this aside, it must be remembered that such a fluid, besides the monads, might contain some unsuspected *bacterium* which might yet be the true cause of the fatality in the group of cases they were observing.

I regret to say that I got but few communications in reply to my query in the "*Pioneer*"; but those I did receive are sufficient to show that the strongyles in question are very common in Burma.

Of especial interest were two letters I received from Dr. Hendley, who was associated with Dr. Evans in his researches on "Surra" in Burma.

Dr. Hendley is, of course, strongly predisposed to the view that the fatality in the cases he observed was referable to the *Trichomonas Evansi*; but the following passages are remarkable, as they clearly show that entozoa were present in some at least of their cases. He says: "In the first cases examined we noticed large numbers of small, round, whitish worms, from half to one and half inches long, imbedded in clusters in cyst-like spaces in the stomach and associated with them, but often without them, ulceration of that organ. These conditions were found in old standing cases, and at first led us to believe that they might be the cause of the disease. However, we discarded the idea when they were not found in cases killed earlier in the course of the complaint. At this lapse of time I cannot say that the whole length of the intestine was slit open in each case; but the examination was generally fairly thorough."

Elsewhere Dr. Hendley remarks: "The stomach and liver appear to be the organs most affected in the body, and ulceration, due to progressive anæmia in the former organ, is one of the most important *post mortem* appearances in long standing cases."

Now, the condition of the stomach here described is thoroughly characteristic of sclerostomiasis; and that worms should be found actually in the stomach in only a small proportion of cases coincides exactly with what I have observed at Shillong, while marks of their previous presence were found in every case examined. The worms he describes were, it is true, possibly not *S. tetracanthum*, but either *Spiroptera megastoma* Rudolphi or *Strongylus Axei* Cobbold, but the ulceration and other appearances correspond exactly with those produced in the stomach by undoubted *S. tetracanthum* at Shillong; so that I cannot but think that, had the cœcum and colon been uniformly examined, they would have discovered strongyles in a far larger proportion of cases than they did in the stomach, or, in other words, that a certain proportion at least of their cases were no more nor less than instances of sclerostomiasis.

As to the prevalence of the worm in Burma, I obtained further, and unequivocal evidence from another correspondent, Captain Hutchinson, commanding the Ye-u battalion of Military Police. He informs me that his corps suffered terribly from "Surra" in 1889, only three ponies surviving out of 176.

The outbreak was coincident with the ponies, while on service, being necessarily allowed to graze in the jungle, instead of being fed on hay, as had previously been the case; and cases have continued to occur up to the present time.

Captain Hutchinson, having noticed my letter in the "*Pioneer*," examined the intestine in the next case that ocurred, and found it swarming with worms, some of which he sent me, and I found that they were, like those found in the Shillong outbreak, *Sclerostumum tetracanthum*. Captain Hutchinson's authority for looking upon the outbreak as one of "Surra" was A. V. Frost, Esq., the Veterinary Inspector of Burma, who had been deputed to enquire into the cause of the outbreak, and whose report on the subject he was good enough to send me. In this report I could find no mention of any examination having been made of the intestines of the affected animals, and indeed, in his letter, Captain Hutchinson remarks: "I regret that last year neither myself, nor my salutri, or Dr. Frost examined the intestine." In his report the Veterinary Inspector states that, out of eighteen animals whose blood he examined he found the *Trichomonas* in fifteen, but in all "the ulceration of the stomach was found to be very well marked." Now ulceration of the stomach is, as has already been remarked, one of the most characteristic of the pathological appearances found in *Sclerostomiasis*, and the life-history of the parasite furnishes obvious reasons why this should be the case. On the other hand, whatever may be the pathological effects caused by the presence of the *Trichomonas Evansi* in the blood, it is very difficult to see any possible reason for their bringing about ulceration of the stomach, and hence one is forced to the conclusion that in these cases the true cause of the lesion was overlooked; the fact being that, once the assumed cause (*i.e.*, the monad) was found to be present, any further examination was assumed to be superfluous. It is right, however, to record that some of the cases described by Captain Hutchinson appear to be referable to what is usually spoken of in India as anthrax; although I understand from Dr. D. D. Cunningham, F.R.S., that its identity with the anthrax of cattle in Europe is a matter of considerable doubt.

Of the prevalence of the parasite in parts of Assam outside the Khasia hills, I obtained evidence in a very interesting letter from Dr. Rudduck of Meesa.

Some years ago he had lost several horses from "Surra" and, on making a thorough examination, he found the only obvious cause of death was the presence of immense numbers of small worms in the cœcum and colon. He preserved some of these, and sent them to "a well known veterinary firm in Calcutta," who reported that two species were present, one of which was the common *Oxyuris curvula*, and the other was "unknown."

The pressure of other work prevented Dr. Rudduck from following up the investigation, and hence he did not publish, or make any further effort to ascertain the character of the "unknown" species; but, when visiting me in Shillong, he at once recognised my specimens of *Sclerostomum tetracanthum* as being identical with the unknown species that had played such havock in his stables.

Few in number though they be, these communications go far to prove the prevalence of the parasite throughout Assam and Burma, and, wherever prevalent, a severe fatality among their equine hosts follows as a necessary consequence.

Further, the very paucity of the number of communications clearly demonstrates how little attention has been bestowed upon parasitic disease among animals in India. Whether these cases should rightly be called "Surra" or not is a matter of the smallest moment; the important fact remains that the parasite in question is a source of serious mortality among equine animals in the tracts of country mentioned; and all that remains to be considered is how far the recognition of this fact can help us in the treatment and, more important still, in the prevention of the malady.

In the treatment of a disease such as that under consideration the importance of forming an early diagnosis is obvious, for the injury caused to the digestive organs by the prolonged presence of the parasites is so serious that the mere expulsion of the worms at a late stage of the disease cannot be expected to effect a cure, as the injured organs will have become incapable of assimilating fresh food to make up for what has been lost. Hence, in countries where these worms are known to be prevalent, animals should be carefully watched and treated promptly, more especially in the direction of preventing further infection. Pressure of other work made my clinical observations scanty and incomplete; but, so far as they go, I am inclined to think that irregular feverish attacks form one of the earliest indications that something is amiss. These feverish attacks, I take it, are brought about by the migration of successive batches of parasites into the submucosa.

As the initial lesions are quite identical with those caused by *Trichina spiralis*, in which the boring of the parasite through the intestinal wall almost uniformly determines feverish symptoms, this is only what might be expected.

Hence attacks of fever, occurring in equine animals in any region infected by the parasite should be viewed with suspicion, and measures taken to ascertain its presence or absence, and owing to the immense numbers of ova produced by them, the determination of this point, by microscopical examination of the dung, is a perfectly easy matter. Owing to the large size of the ova, the lowest powers suffice for the purpose, and the readiest way of making the examination is to stir up a little of the dung in a shallow glass tray containing water, by which means a comparatively large quantity can be searched over in a short time. The measurements and microscopic characters of the ova have already been described, and so need not be repeated here.

It is probable that each successive invasion of parasites, in other words, each infected meal that the animal consumes, will be followed by a feverish attack, and some temperature charts which I saw at Shillong, as well as one supplied me by Dr. H. Hendley as illustrative of the outbreak of "Surra" observed by him in Burma exhibit just such traces as one might expect from a necessarily irregular cause of pyrexia such as this. In Dr. Hendley's chart, reproduced below, dates of observation as to the presence or absence of *Trichominas Evansi* are carefully noted; but I confess I am unable to trace in it any relationship whatever between the pyrexia and the presence or absence of the nomads in question.

Taking the positive observations we find they are placed as below :—

1st Note.—Temperature nearly normal between two steep rises. Present for one day.
2nd ,, At apex of a rise. Present two consecutive days.
3rd ,, Temperature fluctuating a little above the normal. Presenttwo consecutive days.

In nearly all the negative observations the temperature, as in the third positive one, is fluctuating a little above the normal.

Such a trace might of course result from any irregularly acting cause of pyrexia, and I merely draw attention to it in this connection with the view of pointing out that, while the relationship between the course of the temperature and the presence or absence of the trichomonads is by no means obvious, it is in no way incompatible with what one may expect to find in sclerostomiasis.

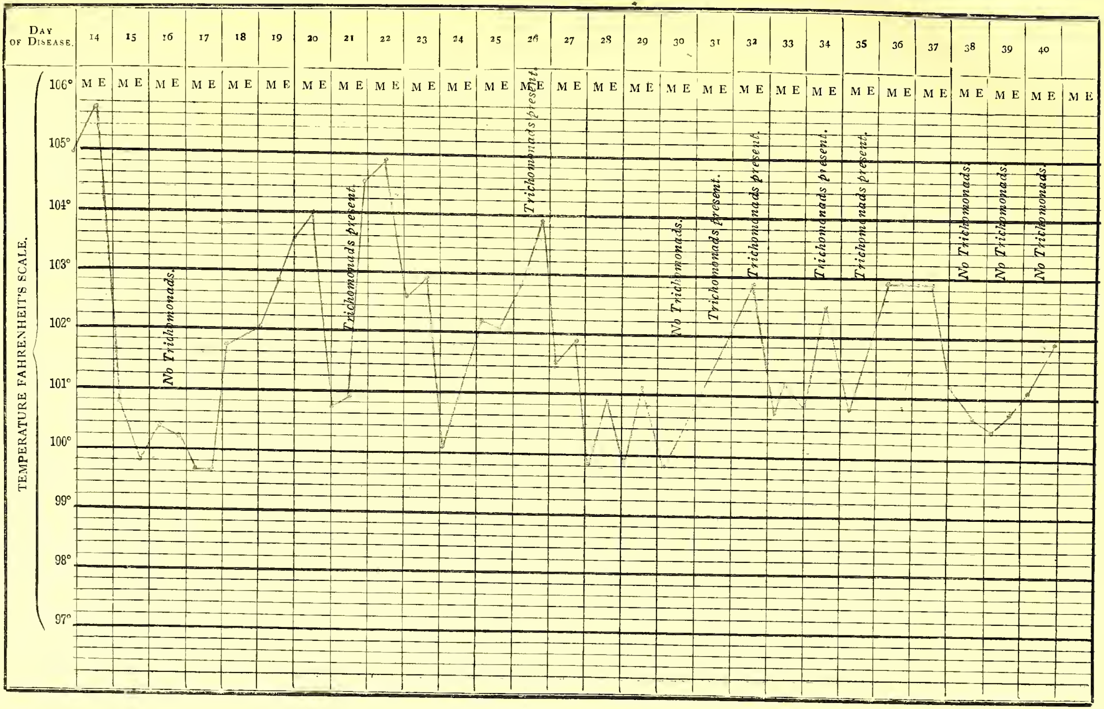
In the chronic stage of the disease, *i.e.*, after the parasites have effected a lodgment, the main symptoms are loss of condition and marked anæmia, best observable on the mucous surfaces of the tongue and conjunctiva.

In the last stages of the disease the temperature is often subnormal.

Assuming the diagnosis to be established, the obvious indication is to expel the worms as quickly as possible; but here my experiences are limited to a single case. I can lay no claim whatever to any knowledge of veterinary medicine, and hence I did not care to institute therapeutic experiments on animals belonging to other folks.

It is quite obvious, however, on general considerations, that no remedy can

Temperature Chart of one of Dr. Hendley's cases of "Surra", in which the animal died on the 53rd day of the disease, eighteen days after the last recorded observation of Trichomonads.



be expected to exercise any effect on the encysted worms, and hence, until they return to the lumen of the intestine, all attempts at their expulsion must be hopeless. So far as I know, we have no data at present at our disposal for estimating the duration of the period of encystment; but, practically speaking, worms in both stages will be present in the majority of cases, and treatment must hence resolve itself into the prevention of re-infection, combined with the periodical administration of anthelmintics in order to expel any worms that may have escaped from encystment before they have time to attain complete maturity, and with it the habit of sucking their victim's blood.

In the case of my own pony I administered $1\frac{1}{2}$ oz. thymol in three doses of $\frac{1}{2}$ oz. each, and the result, as I afterwards found, was to expel nearly every free worm. Ova, however, soon re-appeared in the dung, and believing at the time that this was due to inefficient action of the remedy, owing to its having to reach the lower bowel before it could exercise its action on the worms, I determined to make an attempt to introduce the remedy direct into the colon. I accordingly made an emulsion of thymol by adding it, in spirituous solution, to water, and injected it directly into the colon by means of an aspirator needle. Further, suspecting the original dose might have been too small, I increased the quantity to $2\frac{1}{2}$ oz.

The animal seemed in no pain, and grazed naturally for some time after the operation; but within a few hours toxic symptoms appeared and the animal died, the phenomena presenting a general resemblance to those of carbolic acid poisoning.

Post mortem, it was only after considerable search that the puncture could be found; but it was quite obvious that the whole of the emulsion had passed into the colon.

There was not the least sign of the characteristic smell of the drug to be detected in the peritoneal cavity, and the neighbourhood of the puncture was quite free from redness. In the bowel, enormous numbers of the worms were found in the encysted stage, but only a very few free. There were, however, large numbers of amphistomes, and all these, as well as the few sclerostomes present, were dead for a considerable distance from the point of injection, as far, in fact, as the remedy might be expected to be carried by peristalsis during the time that had elapsed between administration and death. The fatal result was therefore clearly traceable to the largeness of the dose, and not to its method of administration, and, in suitable doses, I still hope that the direct action of the remedy so administered might be taken advantage of, though there can be no absolute need of it, as the result showed that the original dose, administered by the mouth, had acted quite efficiently; and it seems to me that our best hope lies in the repeated administration of this most catholic of all vermifuges, combined with generally supporting treatment, and the administration of easily digestible articles of diet.

Owing, however, to the process of encystment being by far the most formidable source of harm, and the impossibility of touching this by any drug, remedial measures are of quite secondary importance compared with those of prevention; and here the course to be pursued is perfectly obvious, though our success in following it must depend entirely on the means at our disposal.

As it is perfectly clear that infection can only be spread through the agency of the dung of affected animals, the exclusion of all equine animals from the land from which our fodder is derived will alone suffice to stamp out the disease. Hence, in large establishments, the acquisition of grass reserves on which this measure can be carried out is of primary importance; and, for large stables, the establishment of cinerators, in which the dung of all animals may be destroyed by fire, is a further measure that must suggest itself to all who consider the question.

Again, I have experimentally ascertained that temperatures exceeding 140°F. are fatal to the *Rhabditis*, and hence, where the establishment of protected grass reserves is impossible, immunity may be secured by the exposure of all articles of food to this very moderate temperature. For the private owner an apparatus like the ordinary domestic "hot case" for warming plates and dishes would suffice, while a moderately-sized room fitted so as to be well closed and provided with a furnace and flue would suffice for even large establishments. Such a chamber would cost but little either to construct or to maintain, and would amply repay the cost and trouble, in any country where large losses are referable to this disease. It is, by the way, a notable matter that Dr. Hendley informs me that they found that cooking all the food, even to the grass of their equine patients, by far the most effectual agent in treatment, and the fact of their having been able to carry out the system, shows that the difficulties are by no means insuperable.

I must now bring this paper to a close, and fear that I have already trespassed too much on the reader's patience, my only defence being that, though it has run to a larger number of pages than I at all intended, I have done my best to convey my meaning as briefly as possible.

Quite recently I noticed in the columns of one of the daily papers a notice that the question of "Surra" was under examination in the new Bacteriological Laboratory at Poona, and that their investigations had resulted in the discovery of a "bacillus." I await with interest the publication of the results of this investigation, which, if correctly reported, must imply the discovery of a class of cases under the common designation of "Surra" of quite a different character from those affected either by strongyles or by the *Trichomonas Evansi*, assuming the latter, for the moment, to have a causal connection with some of the cases so called.

I hope, however, the investigators will be careful to entirely exclude the action of macroscopic parasites, by a systematic examination of the intestinal canal and its walls.

G. M. GILES, M.B., F.R.C.S.,
Surgeon, I.M.S.,
In Medical Charge, Lawrence Military Asylum,
Sanawar.

SANAWAR;
The 31st January, 1891.

Explanation of Plates.

FIG. 1.—Ovum of *Sclerostomum tetracanthum* from maternal oviduct.

,, 2.—Another in the stage of development usually met with in fresh horse-dung.

,, 3. } Further developed ova from cultivations; the latter contains a well-developed embryo.
,, 4. } ‡

,, 5.—Line $\frac{1}{1000}''$ long on same scale as preceding figures, *i.e.*, × 440 diams.

,, 6.—Recently hatched embryo. Those of the parasitic and free stages are quite identical at this stage.

,, 7.—A further developed Rhabditis, 6 to 8 hours after hatching out.

,, 8.—Another specimen two days old. At *A*, a spindle-shaped body, the rudiment of the generative gland, may be observed.

,, 9.—Scale of $\frac{1}{1000}$ths″ at same amplification as figs. 6, 7, 8, 10, 12 and 13.

,, 10.—Very immature female Rhabditis, about a week old, from a cultivation in the open—

i, intestine.
o, ovary.
v, genital aperture.

,, 11.—Nearly mature male Rhabditis from forage plants.

,, 12.—Oral extremity of the same, more highly magnified, to show the peculiar styloid mouth armature.

,, 13. Caudal extremity of the same to show the clasping spines—

i, intestine.
f, spermatic duct.
c, *c*, clasping spines.
s, copulatory spicula.

,, 14. Scale of $\frac{1}{1000}$ths″ at same amplification as figs. 11 and 15.

,, 15. Mature female Rhabditis from forage plants. The specimen has almost completed the process of laying her eggs, so that comparatively few ova (disposed in single file) are left.

g, œsophageal ganglion.
p, pharyngeal bulb.
l, lemniscus.
i, *i*, intestine.
v, genital aperture.

,, 16. Immature specimen of parasitic stage from a submucous cyst. The generative gland is histologically indeterminate; but the circumstance of the most developed cells being placed in the middle of the gland shows the specimen to be a young female.

,, 17. Scale of $\frac{1}{100}$ths″ at same amplification as fig. 16.

,, 18. Oral extremity of the same specimen, more highly magnified.

,, 19. Scale of $\frac{1}{1000}$ths″ at the same amplification as fig. 18.

PLATE I.

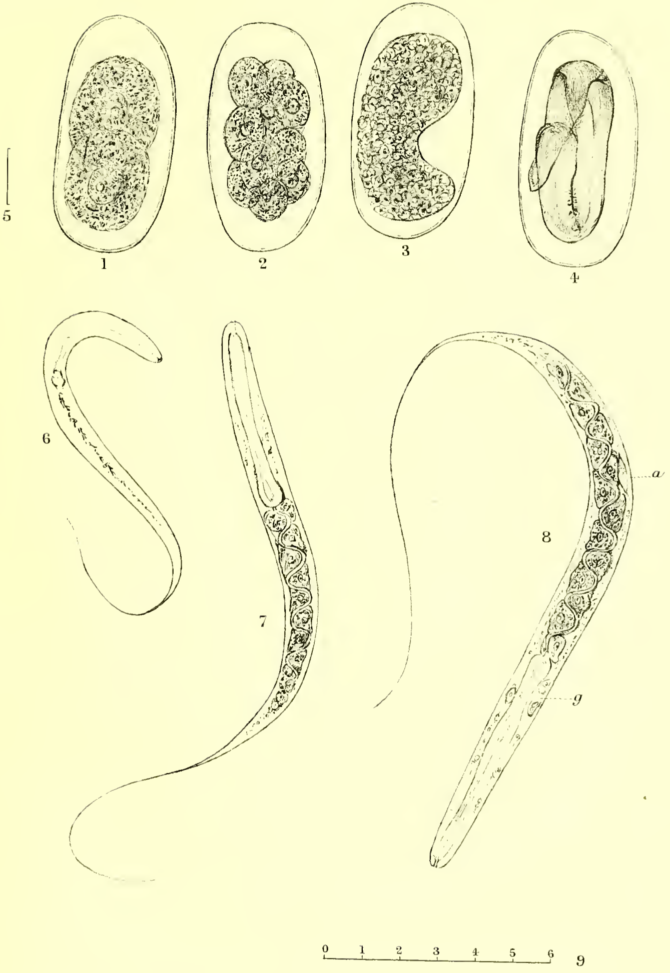


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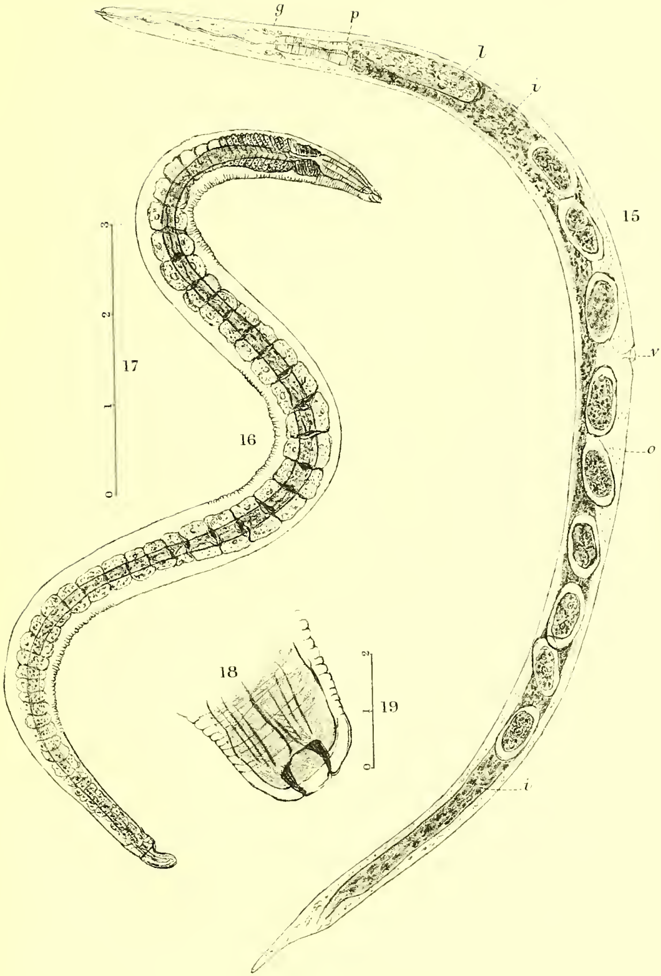
PLATE III.



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